# ASPERA-3 Main Unit Software User's Guide

| | Name and function | Date | Signature |
|---|---|---|---|
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## CHANGE RECORD

| Version | Date | Changed paragraphs | Remarks |
|---|---|---|---|
| Issue 1 Revision 0 | | All | New document |
| Issue 1 Revision 1 | | All | Document moved to official template |

## TABLE OF CONTENTS

*1.*

## 2.ACRONYMS AND DEFINITIONS

| | |
|---|---|
| EEPROM | Electrically Erasable Programmable Read-Only Memory |
| HK | Housekeeping |
| IMA | Ion Mass Analyser |
| MCP | Microchannel plate |
| MU | Main Unit |
| NPD | Neutral Particle Detector |
| NPI | Neutral Particle Imager |
| PROM | Programmable Read-Only Memory |
| S/C | Spacecraft |
| SGICD | Mars Express Space / Ground Interface Control Document, Issue 2 |
| SW, S/W | Software |
| TBC | To Be Confirmed |
| TBD | To Be Defined |
| TBW | To Be Written |
| TC | Telecommand |
| TM | Telemetry |

# 3.GENERAL

## 3.1Software in general

ASPERA-3 Main Unit software is responsible for operating Main Unit according to the telecommands. It will, depending on its mode and received telecommands, produce telemetry. It has also small server for communications with IMA. That server converts telecommands form spacecraft to form known by IMA. It also converts telemetry sent by IMA to form known by spacecraft.

Software runs on MIL-STD-1750 type microprocessor and is written in C (using POSIX threads) and partly in assembler. Compilers used are m1750-gcc by XGC Software. Package includes also version gas (gnu assembler) for MIL-STD-1750.

## 3.2Startup procedure

When the experiment boots it will perform a short self-check. If an anomaly is detected (like watchdog reset), the Main Unit will inform the s/c with an event report packet at the end of the boot process. After a short self check, the s/w will start basic services (TM, limited TC, HK). Then it will check if there's a valid PROM present (on addresses 0x2000-0x3fff in 16bit words) and tries to load the rest of the s/w from there. If the s/w can't be loaded from PROMs, it will try to load a replacement from EEPROM, starting from address (TBD).
If the module can't be loaded from EEPROM nor ROM, the experiment will enter safe mode (actually, stay in safe mode).
If the s/w was loaded successfully, an event report will be generated to show that the experiment has booted properly. Pending error messages from the boot process will be sent. After the boot process, the s/w is in Housekeeping mode generating only Housekeeping data, while it is in fully operational mode (ie. All TCs are available).

## 3.3Shutdown procedure

There isn't any strict s/w requirements for shutdown. Only after Patch EEPROM command it's recommended to wait enough to receive an event reporting about success of eeprom programming process.

## 3.4On commands

### 3.4.1General

One fundamental aspect of the Aspera-3 Main Unit is the way it uses commands (both telecommands and internal commands). Telecommands can be classified in many ways, but most fundamental is division to direct/indirect telecommands. Direct commands are command with type 255 or under 193. These commands are executed immediately after found in telecommand input buffer. Indirect commands are forwarded (after verifying command structure) to specific process, command handler, to be executed later. Telecommands TC(192,1), TC(193,10) and TC(193,11) fall to both categories: If s/w is in safe mode (or some broken state) these commands are used as direct commands. However, in normal situation these are treated as indirect. (TO be implemented, not applicable with current s/w version)
Indirect commands are handled via special `telecommand` table. It's s/w internal structure specifying structures of command including it's type and subtype. It contains also information on functions to be called when indirect command is found. Thanks for this table it's relatively easy to change the way some command behaves without compiling and reprogramming all of the s/w. It is also important to note, that indirect commands (ie. Commands found only in telecommand table) are not available in safe mode.

Further division can be made to classification of commands to safe and hazardous. Hazardous commands must be followed immediately by TC(191,255) containing sequence count of hazardous command. Hazardous commands can't be run from macros.

### 3.4.2On acknowledgments

The ASPERA-3 MU provides only telecommand acceptance acknowledgment for itself. For IMA, acknowledgments are provided by using execution acknowledgments: When an IMA related telecommand is found, the Main Unit will send an acceptance acknowledgment to the s/c (if requested) and then it forwards the command to IMA. If execution acknowledgment is required, IMA will send an acknowledgment to the Main Unit that is waiting for that. This will be forwarded to the s/c.

Although this process is more acceptance than execution type of acknowledgment this has to be used. Due to the acceptance acknowledgment time-out criteria (20s) and the 32-second acquisition period of IMA, it is not possible to have acceptance acknowledgments on IMA.

### 3.4.3On error conditions

Error conditions are reported as event packets. If the error is such that (automatic) recovery process in the MU S/W cannot be executed, the software will enter safe mode or restart itself by using Watchdog reset. Both actions will be reported by the Event packet.

# 4.USING IMA

## 4.1General

IMA commands (type 194 and 195, and memory management sevicr 6 for PID 62) are first received in MU. MU converts commands to valid IEEE1355 link packets, and then sends these to IMA. IMA commands doesn't wait for any other commands (besides other IMA commands) before transmission to IMA. The command acknowledgments scheme is explained in chapter .

## 4.2IMA Server

TBW.

Software part called IMA server is responsible for all link handling.

# 5.TELECOMMANDS

## 5.1General

General structure of telecommands is defined in SGICD.

## 5.2Field descriptions

| *Field name* | *Form* | *Description* |
|---|---|---|
| Parameter | =X | Parameter is constant with value X |
| | X => Y | Parameter can vary in range from X to Y |
| | (X )* n | X is repeated n times |

Parameters are listed in the same order that they appear in the telecommand or telemetry packet so that first parameter to be sent is listed first.

## 5.3Telecommand set Part I: commands defined in SGICD

### 5.3.1TC(3,5): Enable HK Packet generation

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmHKEnable | |
| **Type** | 3 | **PID** | 61 |
| **Subtype** | 5 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | | |
| *General description* | | | |
| **Description** | | Enable HK generation in ASPERA-3 Main Unit | |
| **Note** | | Only housekeeping packet generation of Main Unit can be switched on by this TC | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| None | 2 | =0 | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Generation of MU HK report packet TM(3,20) starts | |

### 5.3.2TC(3,6): Disable HK Packet generation

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmHKDisable | |
| **Type** | 3 | **PID** | 61 |
| **Subtype** | 6 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | | |
| *General description* | | | |
| **Description** | | Disable HK generation in ASPERA-3 Main Unit | |
| **Note** | | Only housekeeping packet generation of Main Unit can be switched off by this TC | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| None | 2 | =0 | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Generation of MU HK report packet TM(3,20) stops | |

### 5.3.3 Load memory using absolute addresses

| *Generic description* | | | | |
|---|---|---|---|---|
| **Acronym** | | | aspmMEMLoad | |
| **Type** | | 6 | **PID** | 61 |
| **Subtype** | | 2 | **Packet Category** | 12 |
| **16 bit parameters** | | varies | | |
| ***General description*** | | | | |
| **Description** | | | Load memory to an absolute address | |
| **Note** | | | Any patch to be loaded to EEPROM must be loaded to mass memory. It can be transferred to EEPROM by TC (193,10) which is available only in safe mode. | |
| ***Parameter description*** | | | | |
| ***Name*** | | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Memory id | | 1 | 0x80 => 0x83 | 0x80: ROM<br>0x82: N / A<br>0x83: MASSMEMORY |
| Number of blocks (=nb) | | 1 | 1=> | Number of blocks to load |
| Data block | Address | 4 | 0 => 0x7FFF | Address of first word in block |
| (repeated nb times) | Length of block (=lb) | 2 | 1 => 0xffff | Number of words in this block |
| | Data | 2*lb | ( 1=> 0xffff) * lb | lb times data words |
| ***Response*** | | | | |
| Immediate response | | | | |
| Related effect | | | | |

### 5.3.4TC(6,5): Dump memory using absolute addresses

| *Generic description* | | | | |
|---|---|---|---|---|
| **Acronym** | | | aspmMEMDump | |
| **Type** | | 6 | **PID** | 61 |
| **Subtype** | | 5 | **Packet Category** | 12 |
| **16 bit parameters** | | varies | | |
| ***General description*** | | | | |
| **Description** | | | Dump memory from an absolute address | |
| **Note** | | | | |
| ***Parameter description*** | | | | |
| ***Name*** | | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Memory id | | 1 | 0x80 => 0x83 | 0x80: ROM<br>0x81: RAM<br>0x82: EEPROM<br>0x83: MASSMEMORY |
| Number of blocks (=nb) | | 1 | 1=> | Number of blocks to dump |
| Data block | Address | 4 | 0 => 0x7FFF | Address of first word in block |
| (repeated nb times) | Length of block (=lb) | 2 | 1 => 0xffff | Number of words in this block |
| ***Response*** | | | | |
| Immediate response | | | Memory dump report packet TM(6,6) | |
| Related effect | | | | |

### 5.3.5TC(9,1): Accept Time update

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmTime | |
| **Type** | 9 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | | |
| ***General description*** | | | |
| **Description** | | Accept time update | |
| **Note** | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| None | - | - | |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | The clock is updated | |

### 5.3.6 Request connection test response

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmConn | |
| **Type** | 17 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | | |
| ***General description*** | | | |
| **Description** | | Test Connection | |
| **Note** | | | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | - | - | - |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | Connection Test Report TM(17,2) | |

### 5.3.7 Enable Science Report Packet Generation on RTU Link

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCIEnable | |
| **Type** | 20 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | | |
| *General description* | | | |
| **Description** | | Enable Science report packet generation on Main Unit. Setup instrument into scientific mode. | |
| **Note** | | This command must be executed before scanner can be operated or science data can be produced. This is due to fact that timing of scanner is tightly coupled with handling of measurement modes. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | - | - | - |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Generation of Science data will be enabled. All scanner operations can be performed after execution of this command. | |

### 5.3.8 TC(20,2): Disable Science Report Packet Generation on RTU Link

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCIDisable | |
| **Type** | 20 | **PID** | 61 |
| **Subtype** | 2 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | | |
| *General description* | | | |
| **Description** | | Disables Science report packet generation on Main Unit. | |
| **Note** | | Science data production will be disabled. Data that has already been measured will be handled and sent. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | - | - | - |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Generation of Science data will be disabled. | |

## 5.4 Telecommand set Part II: commands of type 191

### 5.4.1 TC(191,1): Switch ELS +30V on/off

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmELS30 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Switch ELS +30V on/off | |
| **Note** | | The +30V for ELS controls the high voltages of the deflection plates and MCP. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| On/off | 2 | 0 => 1 | 0=off, 1=on |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | Power indicator telemetry point changes in HK packet. | |

### 5.4.2 TC(191,2): Set ELS Screen Grid Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmELSGrid | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 2 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set ELS Screen grid voltage | |
| **Note** | | Screen grid value determines minimum energy particle detected by ELS. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| Grid voltage | 1 | 0 => 0xFF | Sets screen grid reference voltage |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | Sets screen grid reference telemetry points in HK telemetry packet and in ELS Engineering Information packet. | |

The voltage generated by the MU is linear from 0V to -TBD volts. These values are represented by the parameter limits 0x0000 and 0x00FF, respectively.

### 5.4.3 TC(191,3): Set ELS Deflection Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmELSDef1 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 3 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set ELS deflection plate voltage and deflection power supply range. | |
| **Note** | | Sets a constant value for deflection plate voltage. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 3 bits | =0 | |
| ELS HV Supply Range | 1 bit | 0 => 1 | 0 = Low, 1 = High |
| Deflection voltage | 12 bits | 0 => 0x0FFF | |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | Sets ELS deflection reference to a constant value, reflected in ELS Engineering telemetry packet. | |

The Deflection HV supply range has two states, low range and high range. The control of each supply voltage is generated by the MU. The values linearly range from 0.00 to +5.00 volts and are represented by the parameter limits of 0x0000 and 0x0FFF, respectively.

### 5.4.4TC(191,4) Enable ELS High Voltages

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | aspmELSHV | | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 4 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | Yes |
| ***General description*** | | | |
| **Description** | | Switch ELS High voltages off/on | |
| **Note** | | Command must be verified with TC(191,255) | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| On/off | 2 | 0 => 1 | 0=off, 1=on |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | ELS high voltage enable telemetry state changes in HK packet. | |

### 5.4.5 TC(191,5): Set ELS MCP Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmELSMcp | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 5 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set ELS MCP bias voltage | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| Mcp bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | ELS MCP bias reference telemetry points value reflected in HK packet and in ELS Engineering Information packet. | |

The MU generates a command voltage to control the ELS MCP voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.6 TC(191,7): Switch IMA +30V on/off

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmIMA30 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 7 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Switch IMA +30V on/off | |
| **Note** | | The +30V for IMA controls the high voltages of the deflection and MCP. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| IMA +30V | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | IMA +30V power state indicator telemetry point changes in HK packet. | |

### 5.4.7 TC(191,9): Switch IMA on/off (±5V and ±12V on/off)

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmIMApow | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 9 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Switch IMA ±5V and ±12V on/off | |
| **Note** | | Switch on low voltage power to IMA which controls its activation. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| IMA ± 5V and ±12V | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | IMA ±12V and ±5V power state indicator telemetry points change in HK packet. | |

### 5.4.8TC(191,10): Switch NPD Heaters on/off

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPDheaters | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 10 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Switch NPD heaters on/off | |
| **Note** | | Activate NPD heaters to control the temperature of the NPD instrument. Heaters control both NPD1 and NPD2 temperature. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| NPD Heaters on/off | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD heater status telemetry point changes in HK packet. | |

### 5.4.9TC(191,11): Switch NPD1 +30V on/off

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD130 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 11 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD1 +30V on/off | |
| **Note** | | The +30V for NPD1 controls the high voltages of the deflection and MCP supplies. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| NPD +30V on/off | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Power indicator telemetry point changes in HK packet. | |

### 5.4.10 TC(191,12): Set NPD1 Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1bias | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 12 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set NPD1 bias voltage | |
| **Note** | | Set the value of the MCP bias supply for NPD1. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD1 bias voltage | 1 | 0 => 0xFF | |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | NPD1 bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD1 bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.11TC(191,13): Set NPD1 Deflection Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1defl | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 13 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set NPD1 deflection voltage | |
| **Note** | | Set the value of the deflection voltage for NPD1. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD1 Deflection voltage | 1 | 0 => 0xFF | |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | NPD1 deflection supply reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD1 Deflection voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.12TC(191,14): Set NPD1 Start MCP Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1start | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 14 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD1 start MCP bias voltage | |
| **Note** | | Set the bias reference for the NPD1 start MCP. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD1 Start MCP bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD1 start MCP bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD1 Start MCP bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.13TC(191,15): Set NPD1 Stop MCP Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1stop | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 15 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD1 stop MCP bias voltage | |
| **Note** | | Set the bias reference for the NPD1 stop MCP. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD1 Stop MCP bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD1 stop MCP bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD1 Stop MCP bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.14TC(191,16): Switch NPD2 +30V on/off

| *Generic description* |
|---|

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD230 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 16 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD2 +30V on/off | |
| **Note** | | The +30V for NPD2 controls the high voltages of the deflection and MCP supplies. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| NPD2 +30V on/off | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Power indicator telemetry point changes in HK packet. | |

### 5.4.15TC(191,17): Set NPD2 Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | AspmNPD2bias | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 17 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD2 bias voltage | |
| **Note** | | Set the value of the MCP bias supply for NPD2. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD2 Bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD2 bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD2 bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.16TC(191,18): Set NPD2 Deflection Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD2defl | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 18 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD2 deflection voltage | |
| **Note** | | Set the value of the deflection voltage for NPD2. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD2 Deflection voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD2 deflection supply reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD2 Deflection bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.17TC(191,19): Set NPD2 Start MCP Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD2start | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 19 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD2 start MCP bias voltage | |
| **Note** | | Sets the bias reference for the NPD2 start MCP. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPD2 Start mcp bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD2 start MCP bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD2 Start MCP bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.18TC(191,21): Switch NPI +30V on/off

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPI30 | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 21 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPI +30V on/off | |
| **Note** | | The +30V for NPI controls the high voltages of the deflection and MCP supplies. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| NPI +30V on/off | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Power indicator telemetry point changes in HK packet. | |

### 5.4.19TC(191,22): Set NPI Bias Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPIBias | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 22 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPI bias voltage | |
| **Note** | | Set the value of the MCP bias supply for NPI. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPI Bias voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPI bias reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPD2 Stop MCP bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.20TC(191,23): Set NPI Deflection Voltage

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPIdefl | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 23 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPI deflection voltage | |
| **Note** | | Set the value of the deflection voltage for NPI. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | = 0 | |
| NPI Deflection voltage | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPI deflection supply reference and monitor telemetry points change in HK packet. | |

The MU generates a command voltage to control the NPI bias voltage. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

### 5.4.21TC(191,24): Set NPI Deflection Switch

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPIswitch | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 24 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPI Deflection switch on/off | |
| **Note** | | Turn on/off NPI deflection voltage. | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| NPI Deflection switch on/off | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPI deflection switch indicator telemetry point changes in HK packet. | |

### 5.4.22TC(191,25): Set Scanner Setup

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCANSetupaspmSCANSetup | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 25 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Defines the operation of the scanner. | |
| **Note** | | Scanner +30V on/off and select IRQ operation | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 12 bits | =>0 | |
| Scanner error handler | 1 bit | 0 => 1 | 0=enabled, 1=disabled |
| Auto-switchoff mode | 1 bit | 0 => 1 | 0=enabled, 1=disabled |
| Scan IRQ | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| Scanner +30V on/off | 1 bit | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Scanner +30V power state indicator telemetry point changes in HK packet. | |

### 5.4.23TC(191,26): Set Scanner Voltages

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCANVolts<br>aspmSCANVolts | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 26 | **Packet Category** | 12 |
| **16 bit parameters** | 3 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set scanner voltages and currents | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| VREFMC | 1 | 0 => 0xFF | |
| Coast current | 1 | 0 => 0xFF | |
| Ramp current | 1 | 0 => 0xFF | |
| Threshold CW | 1 | 0 => 0xFF | |
| Threshold CCW | 1 | 0 => 0xFF | |
| Threshold Wheel | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Scanner voltage and current reference telemetry points change in HK packer. | |

The MU generates a command voltage to control the VREFMC. The range varies linearly from 0.00 to +5.00 volts and the values are represented by the parameter limits of 0x000 and 0x00FF, respectively.

Other values are passed to scanner controller board as an digital values.

### 5.4.24TC(191,27): Scanner String Heaters

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCANStrHeat<br>aspmSCANStrHeat | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 27 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | Yes |
| *General description* | | | |
| **Description** | | Release scanner locking mechanism by using string heater 1 or 2 for 15sec.<br><br>Hazardous command on database level. | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Pad | 14 bits | ***=0*** | |
| Stringheater | 2 bits | 0x1 => 0x2 | Number of string heater to be used.<br>0 = N / A<br>1 = String Heater 1<br>2 = String Heater 2<br>3 = N / **A** |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Scanner locking mechanisms should be released. Wether the scanner locking is released or not can be verified by trying to initialize scanner (ie. By moving scanner) | |

### 5.4.25TC(191,30): Enable ASPERA-3 Main Unit watch dog

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmWatchdog | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 30 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description**<br>**Note: May contain disable option** | | Enable Watchdog timer<br>*Watchdog cannot be disabled.<br>* With current version of s/w wd is enabled as a default | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Security code | 2 | =0x2704 | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.4.26TC(191,32) NPD1 High Voltage Switch

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1switch | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 32 | **Packet Category** | 12 |

| *Generic description* | | | |
|---|---|---|---|
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Enable NPD1 high voltage | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| NPD1 HV | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.4.27TC(191,33) NPD2 High Voltage Switch

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD2switch | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 33 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Enable NPD2 high voltages | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| NPD2 HV | 2 | 0 => 1 | 0=off, 1=on |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.4.28TC(191,34): Set NPD1 Counter Thresholds

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD1Tresholds | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 34 | **Packet Category** | 12 |
| **16 bit parameters** | 2 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD1 counter thresholds | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| Start | 1 | 0 => 0xFF | |
| Stop0 | 1 | 0 => 0xFF | |
| Stop1 | 1 | 0 => 0xFF | |
| Stop2 | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPD1 start count and stop count telemetry points change in the NPD1 Science packets. | |

### 5.4.29TC(191,35) Set NPD2 Counter Thresholds

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPD2Tresholds | |
| **Type** | 191 | **PID** | 61 |

| *Generic description* | | | |
|---|---|---|---|
| **Subtype** | 35 | **Packet Category** | 12 |
| **16 bit parameters** | 2 | **Hazardous** | No |
| *General description* | | | |
| **Description** | Set NPD2 counter thresholds | | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Start | 1 | 0 => 0xFF | |
| Stop0 | 1 | 0 => 0xFF | |
| Stop1 | 1 | 0 => 0xFF | |
| Stop2 | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | NPD2 start count and stop count telemetry points change in the NPD2 Science packets. | | |

### 5.4.30TC(191,255): Confirm Hazardous Command

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | aspmLaunch | | |
| **Type** | 191 | **PID** | 61 |
| **Subtype** | 255 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | Confirms previous hazardous command. | | |
| **Note** | This command must follow immediately after command to be confirmed (ie. This must be next command). | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Packet Type | 1 | 191 => 193 | Packet type of the confirmable command. |
| Packet Subtype | 1 | 0 => 255 | Packet subtype of the confirmable command. |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

## 5.5Telecommand set Part III: commands of type 192

### 5.5.1TC(192,1): Select ELS mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmELSmode | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | 2 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Select ELS measurement mode. | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Spare | 1 bit | | |
| Rice Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| Log Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| Energy Compression | 2 bits | 0 => 2 | 0 = 1 step<br>1 = 2 steps<br>2 = 4 steps |
| Time Compression | 3 bits | 0 =>4 | 0 = 1 sweep<br>1 = 2 sweeps<br>2 = 4 sweeps<br>3 = 8 sweeps<br>4 = 16 sweeps |
| Sweep Table Number | 5 bits | | |
| PAD | 1 bit | 0 | |
| Deflection Voltage Sweep Disabled | 1 bit | 0 => 1 | |
| None | 1 bit | 0 => 1 | 0 = inactive, 1 = active |
| Sector Mask | 2 | 0 => 0xFFFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | ELS information changes in the HK packet and the ELS Science telemetry packet | |

### 5.5.2TC(192,6): Set NPI Mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPImode | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 6 | **Packet Category** | 12 |
| **16 bit parameters** | 3 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPI measurement mode | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Stepping Mode | 1 | 0=>255 | 0 = normal mode (no voltage stepping)<br>1-255 = number of samples in one step |
| Accumulation Time | 4 bits | 0 => 15 | Accumulation Time (n) so that one period is 31.25ms * (2 ^ n) |
| PAD | 1 bit | 0 | |
| Log Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| Rice Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| None | 1 bit | 0 => 1 | 0 = inactive, 1 = active |
| Sector Mask | 4 | 0 => 0xFFFFFFFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | NPI information changes in the HK packet and the NPI Science telemetry packet | |

### 5.5.3TC(192,7): Set NPD Mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmNPDmode | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 7 | **Packet Category** | 12 |
| **16 bit parameters** | 3 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set NPD measurement mode | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Integration Factor | 4 bits | | Reserved for TOF mode |
| Accumulation Time | 4 bits | | Accumulation Time (n) so that one period is 31.25ms * (2 ^ n) |
| PAD | 1 bit | 0 | |
| Measurement Mode | 3 bits | 0 => 3 | 0 = Raw Array Mode<br>1 = Bin Matrix Mode<br>2 = TOF Mode<br>3 = PHD Mode |
| Log Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| Rice Compression Enabled | 1 bit | 0 => 1 | 0=disabled, 1=enabled |
| NPD2 active | 1 bit | 0 => 1 | 0=inactive, 1=active |
| NPD1 active | 1 bit | 0 => 1 | 0=inactive, 1=active |
| NPD1 Bin Matrix Reduction | 2 | 0 => 0x0FFF | Bits 12-15 = PAD |

| *Generic description* | | | |
|---|---|---|---|
| Tables | | | Bits 8 – 11 = Dir 2<br>Bits 4 – 7 = Dir 1<br>Bits 0 - 3 = Dir 0 |
| NPD2 Bin Matrix Reduction Tables | 2 | 0 => 0x0FFF | Bits 12-15 = PAD<br>Bits 8 – 11 = Dir 2<br>Bits 4 - 7 = Dir 1<br>Bits 0 - 3 = Dir 0 |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | NPD information changes in the HK packet and the NPD Science telemetry packet | |

### 5.5.4TC(192,12): Set MU HK Packet Generation Frequency

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmHKDelay | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 12 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set HK Generation Frequency | |
| **Note** | | | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | 2 | 0 => 0xffff | Delay in seconds |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.5.5TC(192,13): Set Scanner mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCANmode | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 13 | **Packet Category** | 12 |
| **16 bit parameters** | 2 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Set Scanner mode | |
| **Note** | | In scanning mode (mode = 1), second parameter must be sent but doesn't affect anything. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 5 bits | 0 | |
| Scanner mode | 3 bits | 0 => 3 | 0 = Standing (scanner on)<br>1 = Scanning<br>2 = Stepping<br>3 = Not in use (scanner off) |
| Scanner speed | 1 | 0 => 3 | 0 = Shutdown<br>1 = 32 sec per scan<br>2 = 64 sec per scan<br>3 = 128 sec per scan |
| Scanner cycle duration | 1 | 0 => 0xFF | Length of measurement cycle (n) so that cycle lasts for 31.25ms * (2 ^ n). |

| *Generic description* | | | |
|---|---|---|---|
| Scanner step angle or Scanner position (based upon Mode Setting) | 1 | 0 => 0xFF | Standing mode => Position<br>Stepping mode => Step Angle |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Scanner information changes in the HK packet and the Scanner Information telemetry packet | |

### 5.5.6TC(192,14): Initialize Scanner

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSCANinit | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 14 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Initialize Scanner | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 7 bits | 0 | |
| Scanner init | 1 bit | 0 => 1 | 0 = test communication and initialization<br>1 = test communication only |
| Communication test value | 1 | 0 => 0xFF | test value |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.5.7TC(192,16): Set High Voltage Shutter Reduced Voltages

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmHVShutVolts | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 16 | **Packet Category** | 12 |
| **16 bit parameters** | 3 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set HV shutter reduced voltages | |
| **Note** | | Set HV shutter reduced voltages | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | 0 | |
| NPI Bias | 1 | 0 => 0xFF | |
| NPD1 Stop Bias | 1 | 0 => 0xFF | |
| NPD1 Start Bias | 1 | 0 => 0xFF | |
| NPD2 Stop Bias | 1 | 0 => 0xFF | |
| NPD2 Start Bias | 1 | 0 => 0xFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | Bias reference telemetry point values change in the HK packet | |

### 5.5.8TC(192,15): Set High Voltage Shutter Mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmHVShut | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 15 | **Packet Category** | 12 |
| **16 bit parameters** | varies | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Set HV shutter mode | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Test mode | 1 bit | 0: off<br>1:on | In solar sensor mode only |
| Mode | 3 bits | 0: off<br>1: Solar sensor with init<br>2: Test scan only<br>3: NPD Countrate<br>4: External | |
| Others, varies with mode | 12 bits | | |
| Others, varies with mode | 8 | | |
| | Command interpretation in solar sensor mode: | | |
| Test mode | 1 bit | 0: off<br>1:on | |
| Mode | 3 bits | 1: Solar sensor with init | |
| Re-init period | 8 | Number of measurement cycles | |
| PAD | 2 bits | | |
| Scanner speed | 2 bits | 0: default (32s)<br>1: 32s<br>2: 64s<br>3: 128s | |
| Solarsensor 1 CW limit | 1 | | Valid if test mode specified |
| Solarsensor 1 CCW limit | 1 | | Valid if test mode specified |
| Solarsensor 2 CW limit | 1 | | Valid if test mode specified |
| Solarsensor 2 CCW limit | 1 | | Valid if test mode specified |
| PAD | 4 | | |
| | Command interpretation in NPD countrate mode: | | |
| Test mode | 1 bit | 0: off | |
| Mode | 3 bits | 3: NPD Countrate | |
| Duration | 12bits | Duration (n) so that reduced voltages are used for 31.25*(n+1) ms | |
| Countrate criteria for NPD1 | 2 | | |
| Countrate criteria for NPD2 | 2 | | |
| PAD | 4 | | |
| | Command interpretation in Ext mode: | | |
| Test mode | 1 bit | 0: off | |
| Mode | 3 bits | 4: Ext Countrate | |
| Duration for NPI shutter | 12 bits | Duration (n) so that reduced voltages are used for 31.25*(n+1) ms | |
| CW position for NPI shutter | 1 | | |
| CCW pos for NPI shutter | 1 | | |
| PAD | 4 bits | | |
| Duration for NPD1 and NPD2 shutter | 12 bits | Duration (n) so that reduced voltages are used for 31.25*(n+1) ms | |

| *Generic description* | | |
|---|---|---|
| CW position for NPD1 shutter | 1 | |
| CCW position for NPD1 shutter | 1 | |
| CW position for NPD2 shutter | 1 | |
| CCW position for NPD2 shutter | 1 | |
| ***Response*** | | |
| Immediate response | | |
| Related effect | | Telemetry point values change in the HK packet |

### 5.5.9TC(192,20) Run Macro

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmMacroRun | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 20 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Run macro | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| PAD | 1 | =0 | |
| Macro Number | 1 | 0 =>0xFF | 0 – 191 range of values |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.5.10 TC(192,21) Terminate Current Macro

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmMacroTerminate | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 21 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Terminate current macro | |
| **Note** | | This command cannot be used in a macro. | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | - | - | - |
| ***Response*** | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.5.11TC(192,22) Run Single Macro Command

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmMacroRunCmd | |
| **Type** | 192 | **PID** | 61 |
| **Subtype** | 22 | **Packet Category** | 12 |

| *Generic description* | | | |
|---|---|---|---|
| **16 bit parameters** | varies | **Hazardous** | No |
| *General description* | | | |
| **Description** | Run single macro command | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | 2 | = 0x2704 | |
| Confirm Word | 2 | | type+subtype as in aspmLaunch |
| Type | 1 | 0=>0xFF | |
| SubType | 1 | 0=>0xFF | |
| None | 2 | = 0x0 | |
| Number of Parameters | 1 | 0=>0xFF | |
| None | 1 | = 0x0 | |
| Parameters | varies | | as many as specified above |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

## 5.6Telecommand set Part IV: commands of type 193

### 5.6.1TC(193,1): Pipe Telecommand

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmPipe | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 12 |
| **16 bit parameters** | varies | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Pipe TC to TM | |
| **Note** | | Send parameters back to telemetry | |
| *Parameter description* | | | |

| *Response* |
|---|
| Immediate response<br>Piped TC report packet TM (193, 128) |
| Related effect |

### 5.6.2TC(193,2): Relax (do nothing)

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmRelax<br>aspmRelax | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 2 | **Packet Category** | 12 |
| **16 bit parameters** | 0 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Relax ie. Do nothing | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| None | - | - | - |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.6.3TC(193,3): Generate simulated data

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmSim<br>aspmSim | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 3 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Generate simulated data<br>Generate simulated data | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Simulation enabled | 2 | 0 => 1 | 0: simulation disabled<br>1: simulation enabled |
| *Response* | | | |
| Immediate response | | | |

| *Generic description* |
|---|
| Related effect |

### 5.6.4TC(193,4): Write word to address

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmWrite | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 4 | **Packet Category** | 12 |
| **16 bit parameters** | 2 | **Hazardous** | Yes |
| *General description* | | | |
| **Description** | | Write word to address | |
| **Note** | | Command must be verified with TC(191, 255) | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Address | 2 | 0 => 0xFFFF | |
| Data word | 2 | 0 => 0xFFFF | |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.6.5TC(193,5): Read word from address

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmRead | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 5 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Read word from address | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Address | 2 | 0 => 0xFFFF | |
| *Response* | | | |
| Immediate response | | Read word report packet TM(193,6)<br>Read word report paclet TM(193,6) | |
| Related effect | | | |

### 5.6.6TC(193,10): Patch EEPROM

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmPatch | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 10 | **Packet Category** | 12 |
| **16 bit parameters** | 6 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Patch eeprom (starting from absolute address) using specified number of words found from Massmemory at specified absolute address. | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Massmemory address | 4 | 0 => 0x0007 FFFF | |
| Eeprom address | 4 | 0 => 0x0003 FFFF | |
| Patch Mode | 1 bit | 0 => 1 | 0 = Patch without using paging mode |

| *Generic description* | | | |
|---|---|---|---|
| Patch length | 15 bits | 1 => 0x7FFF | 1 = Patch using paging mode<br>Length of patch in 16bit words |
| Patch CRC checksum | 2 | 0 => 0xFFFF | CRC checksum calculated over whole patch |
| ***Response*** | | | |
| Immediate response | | EVENT:<br>EEPROM PROGRAMMED<br>or<br>EEPROM PROGRAMMING NOT SUCCESSFUL<br>or<br>EEPROM PROGRAMMING CRC ERROR | |
| Related effect | | | |

### 5.6.7TC(193,11): Load Module

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmModule | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 11 | **Packet Category** | 12 |
| **16 bit parameters** | 3 | **Hazardous** | No |
| ***General description*** | | | |
| **Description** | | Load Module | |
| **Note** | | | |
| ***Parameter description*** | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Address | 4 | 0 => 0x0007 FFFF | |
| PAD | 6 bits | 0 | |
| Execution Flag | 1 bit | 0 => 1 | 0 = Load and run module<br>1 = Load but don't run module |
| CRC Verify | 1 bit | 0 => 1 | 0 = Verify crc<br>1 = Don't verify crc |
| Memory ID | 1 | = 0x82 | (EEPROM) |
| ***Response*** | | | |
| Immediate response | | EVENT:<br>MODULE LOADED<br>or<br>MODULE LOAD FAILED | |
| Related effect | | | |

### 5.6.8TC(193,12) Select Boot Mode

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmBootMode | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 12 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Select boot mode | |
| **Note** | | No use after boot process | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Boot Mode | 1 | 1 => 2 | 1 = Safe Mode<br>2 = Normal Mode |
| *Response* | | | |
| Immediate response | | | |
| Related effect | | | |

### 5.6.9TC(193,16): Watchdog reset

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | aspmWDReset<br>aspmWDReset | |
| **Type** | 193 | **PID** | 61 |
| **Subtype** | 16 | **Packet Category** | 12 |
| **16 bit parameters** | 1 | **Hazardous** | No |
| *General description* | | | |
| **Description** | | Force watchdog reset | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Security code | 2 | =0x2704 | |
| *Response* | | | |
| Immediate response | | Events<br>I'M ALIVE<br>and<br>WATCHDOG RESET | |
| Related effect | | | |

## 5.7List of telecommands

| *Telecommand* | *Acronym* | *Description* | *Number of Parameters* |
|---|---|---|---|
| TC (3, 5) | aspmHKEnable | Enable HK generation | 1 |
| TC (3, 6) | aspmHKDisable | Disable HK generation | 1 |
| TC (6, 2) | aspmMEMLoad | Load memory | 4 |
| TC (6, 5) | aspmMEMDump | Dump memory | 4 |
| TC (9, 1) | aspmTime | Accept Time Update | 0 |
| TC (17, 1) | aspmConn | Connection Test | 0 |
| TC (20, 1) | aspmSCIRnable | Enable Science on RTU link | 0 |
| TC (20, 2) | aspmSCIDisable | Disable Science on RTU link | 0 |
| TC (191, 1) | aspmELS30 | Switch ELS +30V On/Off | 1 |
| TC (191, 2) | aspmELSGrid | Set ELS Screening Grid Voltage | 1 |
| TC (191, 3) | aspmELSDefl | Set ELS Deflection voltage and switch | 1 |
| TC (191, 4) | aspmELSHV | Switch ELS High Voltage On/Off | 1 |
| TC (191, 5) | aspmELSMcp | Set ELS mcp bias voltage | 1 |
| TC (191, 7) | aspmIMA30 | Switch IMA +30V on/off | 1 |
| TC (191, 9) | aspmIMAPow | Switch MA ± 5V and ± 12V on/off | 1 |
| TC (191, 10) | aspmNPDheaters | Switch NPD heaters on/off | 1 |
| TC (191, 11) | aspmNPD130 | Set NPD1 +30V on/off | 1 |
| TC (191, 12) | aspmNPD1bias | Set NPD1 bias | 1 |
| TC (191, 13) | aspmNPD1defl | Set NPD1 deflection bias | 1 |
| TC (191, 14) | aspmNPD1start | Set NPD1 Start bias | 1 |
| TC (191, 15) | aspmNPD1stop | Set NPD1 Stop bias | 1 |
| TC (191, 16) | aspmNPD230 | Set NPD2 +30V on/off | 1 |
| TC (191, 17) | aspmNPD2bias | Set NPD2 bias | 1 |
| TC (191, 18) | aspmNPD2defl | Set NPD2 deflection bias | 1 |
| TC (191, 19) | aspmNPD2start | Set NPD2 Start bias | 1 |
| TC (191, 20) | aspmNPD2stop | Set NPD2 Stop bias | 1 |
| TC (191, 21) | aspmNPI30 | Set NPI +30V on / off | 1 |
| TC (191, 22) | aspmNPIBias | Set NPI Bias | 1 |
| TC (191, 23) | aspmNPIDefl | Set NPI Deflection Voltage | 1 |
| TC (191, 24) | aspmNPISwitch | Set NPI Switch | 1 |
| TC (191, 25) | aspmSCANSetup | Set Scanner Setup | 1 |
| TC (191, 26) | aspmSCANVolts | Set Scanner voltages | 3 |
| TC (191, 27) | aspmSCANStrHeat | Set stringheaters on / off | 1 |
| TC (191, 30) | aspmWatchdog | Enable Watchdog | 1 |
| TC (191, 32) | aspmNPD1switch | Set NPD1 high voltages | 1 |
| TC (191, 33) | aspmNPD2switch | Set NPD2 high voltages | 1 |
| TC (191, 34) | aspmNPD1Tresholds | Set NPD1 counter tresholds | 2 |
| TC (191, 35) | aspmNPD2Tresholds | Set NPD2 counter tresholds | 2 |
| TC (191, 255) | aspmLaunch | Confirm Hazardous Command | 1 |
| TC (192, 1) | aspmELSmode | Set ELS mode | 2 |
| TC (192, 6) | aspmNPImode | Set NPI mode | 3 |
| TC (192, 7) | aspmNPDmode | Set NPD mode | 3 |
| TC (192, 12) | aspmHKDelay | Set HK generation frequency | 1 |
| TC (192, 13) | aspmSCANmode | Set scanner mode | 2 |
| TC (192, 14) | aspmSCANinit | Initialize scanner | 1 |
| TC (192, 15) | aspmHVShut | Set HV Shutter mode | Varies |
| TC (192, 16) | aspmHVShutVolts | Set HV shutter reduced voltages | 3 |
| TC (192, 20) | aspmMacroRun | Run macro | 1 |
| TC (192, 21) | aspmMacroTerminate | Terminate current macro | 0 |
| TC (192, 22) | aspmMacroRunCmd | Run single macro command | Varies |
| TC (193, 1) | aspmPipe | Pipe TC to TM | Varies |
| TC (193, 2) | aspmRelax | Relax, ie. Do nothing | 0 |
| TC (193, 3) | aspmSim | Generate simulated data | 1 |
| TC (193, 4) | aspmWrite | Write to address | 2 |
| TC (193, 5) | aspmRead | Read from address | 1 |

| *Telecommand* | *Acronym* | *Description* | *Number of Parameters* |
|---|---|---|---|
| TC (193, 10) | aspmPatch | Patch eeprom | 6 |
| TC (193, 11) | aspmModule | Load module | 3 |
| TC (193, 12) | aspmBootMode | Select boot mode | 1 |
| TC (193, 16) | aspmWDReset | Watchdog reset | 1 |

# 6.TELEMETRY

## 6.1General

## 6.2Telemetry packages

### 6.2.1TM(1,1): Telecommand Acceptance report - Success

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMTCAck | |
| **Type** | 1 | **PID** | 61 |
| **Subtype** | 1 | **Packet Category** | 1 |
| **16 bit parameters** | 4 | | |
| *General description* | | | |
| **Description** | | Telecommand acceptance report | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| Telecomand packet ID | 2 | 0 => 0xFFFF | |
| Telecommand packet sequency control | 2 | 0 => 0xFFFF | |
| *Long description* | | | |
| *In SGICD* | | | |

### 6.2.2TM(1,2): Telecommand Acceptance report - Failure

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMTCNack | |
| **Type** | 1 | **PID** | 61 |
| **Subtype** | **2**-Packet Category | | |
| **16 bit parameters** | **Varies-** | | |
| *General description* | | | |
| **Description** | | Telecommand acceptance report - -failure | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| | | | |
| | | | |
| *Long description* | | | |
| In SGICD - No changes or additions to that definition has been made | | | |

### 6.2.3TM(1,7): TM Execution acknowledgment report – Success

As specified in SGICD

### 6.2.4TM(1,8): TM Execution acknowledgment report – Failure

As specified in SGICD

### 6.2.5TM(3,20): Housekeeping report

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMHKRep / ASPIHKRep | |
| **Type** | 3 | **Subtype** | 20 |
| **APID** | | 61 => 62 | |
| **16 bit parameters** | | Varies | |
| *General description* | | | |
| **Description** | | Housekeeping report | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| | | | |
| | | | |
| *Long description* | | | |
| Description later in this document | | | |

### 6.2.6TM(6,6)Memory dump report packet

As specified in SGICD.

### 6.2.7TM(17,2): Connection test report

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMConnRep | |
| **Type** | 17 | **Subtype** | -2 |
| **APID** | | 61 | |
| **16 bit parameters** | | | |
| *General description* | | | |
| **Description** | | Connection test report | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| | | | |
| | | | |
| *Long description* | | | |
| In SGICD | | | |

### 6.2.8TM(20,3): Science data report

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMScienceRep | |
| **Type** | 20 | **Subtype** | 3 |
| **APID** | | 61 | |
| **16 bit parameters** | | Varies | |
| *General description* | | | |
| **Description** | | Science data report | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| | | | |
| | | | |
| *Long description* | | | |
| Definition later in this document | | | |

### 6.2.9TM(193,6): Read word report packet

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMReadRep | |
| **Type** | 193 | **Subtype** | 6 |
| **APID** | | 61 | |
| **16 bit parameters** | | 2 | |
| *General description* | | | |
| **Description** | | Word read from address specified in packet TC(193,5) | |
| **Note** | | | |
| *Parameter description* | | | |
| ***Name*** | ***Size (bytes)*** | ***Value*** | ***Note*** |
| Address | 2 | Any | Address of word |
| Data | 2 | Any | Word read from address |
| *Long description* | | | |

| *Generic description* |
|---|
| |

### 6.2.10TM(193,128): Piped TC report packet

| *Generic description* | | | |
|---|---|---|---|
| **Acronym** | | ASPMPipeRep | |
| **Type** | 193 | **Subtype** | 128 |
| **APID** | | 61 | |
| **16 bit parameters** | | Varies | |
| *General description* | | | |
| **Description** | | Piped Telecommad | |
| **Note** | | | |
| *Parameter description* | | | |
| *Name* | *Size (bytes)* | *Value* | *Note* |
| | | | |
| | | | |
| *Long description* | | | |
| Parameters should be exact copy of source data field (without checksum) of received telecommand aspmPipe | | | |

### 6.3Telemetry list

| *Telecommand* | *Acronym* | *Description* | *Note* |
|---|---|---|---|
| TM (1, 1) | aspmTCAck | Telecommand acceptance report – Success | |
| TM (1, 2) | AspmTCNack | Telecommand acceptance report – Failure | |
| TM (1, 7) | AspiTCEAck | Telecommand execution report – Success | Only from IMA |
| TM (1, 8) | aspiTCENAck | Telecommand execution report – Failure | Only from IMA |
| TM (6,6) | AspmMemDumpRep / aspiMemDumpRep | Memory dump report packet for MU / IMA | |
| TM (6, X) | AspiMemCheckRep | Memory check report for IMA | Only for iMA |
| TM (3, 25) | AspmHKRep / AspmHKRep | Housekeeping packet fro MU / IMA | |
| TM (17, 2) | aspmConnRep | Connection Test response | |
| TM (20, 3) | AspmScienceRep / aspiScinceRep | Enable Science on RTU link for MU/IMA | |
| TM (193,6) | ASPMReadRep | | |
| TM (193,128) | aspmSCIDisable | Disable Science on RTU link | |

# 7.EVENT REPORTING

## 7.1General

All events from the MU are formatted according to the same scheme: First word (after headers, ie. Word number 8) is the event number. The following two words are freely chosen extra information about the event, typically just zeros. Events generated by the MU are of type TM(5,1) to TM(5,2), as specified in the SGICD. Subtype 1 corresponds to normal progress and subtype 2 corresponds to a warning.

## 7.2Event List

The following table defines all events produced by the MU. If extra parameters are not specified, these are constant zeros.

| *Event number* | *Event name* | *Parameter 1* | *Parameter 2* | *Description* |
|---|---|---|---|---|
| 40001 | I'm Alive | | | Generated after normal boot process as a first event |
| 40003 | Going to reboot | | | |
| 40004 | Watchdog reset | wd_mask | wd_mask cleared | |
| 40005 | Going to safe mode | | | |
| 40006 | Going to normal mode | | | |
| 40007 | Telecommand buffer overflow | | | |
| | | | | |
| | | | | |
| 40010 | Eeprom programmed | | | |
| 40011 | Eeprom programming - nonsuccess | CRC check sum in patch | CRC checksum in programmed Eeprom area | |
| 40012 | CRC error in Eeprom patch | CRC check sum in patch | CRC checksum specified in TC | |
| 40013 | Module loaded | | | |
| 40014 | Module load failed | Error code defining exact type of error | Optional Extra information | |
| 40015 | Default boot module loaded | | | |
| 40016 | Default boot module loading failed | Error code defining exact type of error | Optional Extra information | |
| 40020 | Command handler error | 1: command not confirmed properly<br>16: other error<br>0xffff: command not found | Seq count of command raising error | |
| 40021 | Invalid confirmation by TC(191,255) | For Command to be confirmed:<br>Bit 8-15: type<br>bit 0-7: Subtype | From the confirmation parameters:<br>Bit 8-15: type<br>bit 0-7: Subtype | |
| 40022 | Invalid mode definition | Upmost address for the data storage of invalid mode | | |
| | | | | |
| 40026 | Macro execution succesful | Macro number | | |
| 40027 | Macro terminated by TC | Macro number | Command index in macro command buffer | |
| 40028 | Macro Checksum error in EEPROM | Calculated checksum | Checksum in EEPROM | |
| 40029 | Macro Can't start | | | |
| | | | | |
| 40074 | IMA command buffer full | | | |
| 40092 | Scanner initialized | | | |
| 40097 | Scanner error | 2: Communication test failed before initialization<br>3: Initialization failed.<br>4: Can't start scanner properly<br>5: Scanner not stopped properly<br>6: Scanner not initialized<br>7: Can't escape endposition on | | |

| *Event number* | *Event name* | *Parameter 1* | *Parameter 2* | *Description* |
|---|---|---|---|---|
| | | initialization<br>8: Science not enabled | | |
| | | | | |
| | | | | |
| | | | | |

# 8.HOUSEKEEPING

## 8.1General

The ASPERA-3 Main Unit will have one type of housekeeping (HK) packet which contains all HK signals and parameters.

## 8.2HK packet source data field

### 8.2.1Source data field for Main Unit

#### 8.2.1.1Generic structure

After headers, there will be the source data field. For the HK report packet, it will be as shown below:

| *Byte* | *Bits* | *Field* | *Note* |
|---|---|---|---|
| **Source data field** | | | |
| 16 | | PAD | for TM(3, 20) always 0 |
| 17 | | SID | |
| 18-119 | | Parameters | Full HK packet |

The SID field will contain an identifier telling which type of HK packet is being sent. ( For the Main Unit, the full Housekeeping packet is identified by setting SID to 0.

For IMA, the SID numbers are TBD, starting with SID=10. They can also be recognized by examining the application id field.

#### 8.2.1.2Full Housekeeping Packet:

The full HK packet will have the following format. Bit number 0 will be the LSB (ie. numbering is NOT the same as defined in the SGICD). If not otherwise stated, the fields will contain exactly the value read from hardware. This means,that the definition of every hw field is stated in XXX (document defining hw signals,TBD).

| *Byte* | *Bits* | *Field* | *Note* |
|---|---|---|---|
| 18 | | els_temp | |
| 19 | | npd1_temp | |
| 20 | | npd2_temp | |
| 21 | | npi_temp | |
| 22 | | scanner_temp_sensor | |
| 23 | | PAD | |
| 24-25 | | sw_version | Software version |
| 26 | | els_minus_5v_screen_grid_ref | sw monitored |
| 27 | | els_minus_5v_screen_grid_mon | |
| 28 | | els_bias_mcp_ref | sw monitored |
| 29 | | els_bias_mcp_mon | |
| 30-31 | 15 | els_plus_30v_on_off | |
| | 14 | els_enable_hv | sw monitored |
| | 8-13 | els_table_index | There is number of tables stored in EEPROM, but only one is currently loaded into RAM. Table number of is defined in ELS mode command. Number of loaded is table showed here. |
| | 7 | els_range | sw monitored |
| | 0-6 | PAD | sw_monitored |
| | | | |
| 32 | | hk_i_plus_30v | |
| 33 | | hk_i_plus_5v | |
| 34 | | hk_v_plus_12v | |
| 35 | | hk_v_plus_30v | |
| 36 | | hk_v_plus_5v | |
| 37 | | hk_v_minus_12v | |
| 38 | | hk_v_minus_5v | |
| 39 | 7 | NPD1_defl_switch | |
| | 6 | NPD2_defl_switch | |
| | 5 | Sun sensor 2 | |
| | 4 | Sun sensor 1 | |
| | 3 | PAD | |
| | 2 | npd_heaters_on_off | sw monitored |
| | 1 | npd1_plus_30v_on_off | |
| | 0 | npd2_plus_30v_on_off | |
| 40 | | npd1_bias_mon | |
| 41 | | npd1_bias_ref | sw monitored |
| 42 | | npd1_defl_mon | |
| 43 | | npd1_defl_ref | sw monitored |
| 44 | | npd1_start_bias_mon | |
| 45 | | npd1_start_bias_ref | sw monitored |
| 46 | | npd1_stop_bias_mon | |
| 47 | | npd1_stop_bias_ref | sw monitored |
| 48 | | npd1_frontctrl | |
| 49 | | npd1_mainctrl | |
| 50-51 | | npd1_stat | |
| 52-53 | | npd1_tdcrd | |
| 54-55 | | npd1_calib11 | |
| 56-57 | | npd1_calib12 | |
| 58-59 | | npd1_calib21 | |
| 60-61 | | npd1_calib22 | |
| 62-63 | | npd1_sefccnt | |
| 64-65 | | npd1_defccnt | |
| 66 | | npd2_bias_mon | |
| 67 | | npd2_bias_ref | sw monitored |
| 68 | | npd2_defl_mon | |
| 69 | | npd2_defl_ref | sw monitored |
| 70 | | npd2_start_bias_mon | sw monitored |

| *Byte* | *Bits* | *Field* | *Note* |
|---|---|---|---|
| 71 | | npd2_start_bias_ref | |
| 72 | | npd2_stop_bias_mon | |
| 73 | | npd2_stop_bias_ref | sw monitored |
| 74 | | npd2_frontctrl | |
| 75 | | npd2_mainctrl | |
| 76-77 | | npd2_stat | |
| 78-79 | | npd2_tdcrd | |
| 80-81 | | npd2_calib11 | |
| 82-83 | | npd2_calib12 | |
| 84-85 | | npd2_calib21 | |
| 86-87 | | npd2_calib22 | |
| 88-89 | | npd2_sefccnt | |
| 90-91 | | npd2_defccnt | |
| 92 | | npi_bias_ref | sw monitored |
| 93 | | npi_bias_mon | |
| 94 | | npi_defl_ref | sw monitored |
| 95 | | npi_defl_mon | |
| | | | |
| 96 | 7 | npi_plus_30v_on_off | sw monitored |
| | 6 | npi_defl_switch | sw monitored |
| | 5 | npi_defl_mode | sw monitored |
| | 3-4 | SPARE4 | |
| | 2 | ima_plus_minus_12v_on_off | sw monitored |
| | 1 | ima_plus_30v_on_off | sw monitored |
| | 0 | ima_plus_minus_5v_on_off | sw monitored |
| | | | |
| 97 | | scanner_vrefmc | |
| 98 | 7 | scanner_status_ccw_end_pos | |
| | 6 | scanner_status_cw_end_pos | |
| | 5 | scanner_status_pos_clock | |
| | 4 | scanner_status_direction | 0: 0 - 180 1: 180 - 0 |
| | 2-3 | scanner_status_state | 0: Not busy 1: ramp up<br>2: Full speed move 3: Ramp down |
| | 1 | Lost step | |
| | 0 | scanner_initialized | |
| 99 | 7 | scanner_plus_30v_on_off | |
| | 5-6 | PAD | |
| | 4 | scanner_setup_mode | 0: normal 1: manual |
| | 3 | scanner_setup_direction | 0: 0 - 180 1: 180 - 0<br>for manual mode speed command only |
| | 2 | PAD | |
| | 0-1 | scanner_speed | 0: STOP 1: 32s scan<br>2: 64s scan 2: 128s scan |
| 100 | | scanner_coast_current_ref | |
| 101 | | scanner_ramp_current_ref | |
| 102 | | scanner_treshold_cw_ref | |
| 103 | | scanner_treshold_ccw_ref | |
| 104 | | scanner_treshold_wheel_ref | |
| 105 | | scanner_position | |
| | | | |

| *Byte* | *Bits* | *Field* | *Note* |
|---|---|---|---|
| 106 | | sw_mode | sw monitored |
| 107 | | cpu_load | sw monitored |
| 108-109 | | ELS Sector mask | sw monitored |
| 110-111 | 8-15 | ELS compression scheme (ie. defines mode) | sw monitored |
| | 0-7 | ima_link_status | |
| 112-115 | | NPI Sector mask | |
| 116-117 | 9-15 | PAD | |
| | 7-8<br>6 | NPI Mode<br>PAD | |
| | 2-5 | NPI Accumulation time | |
| | 1 | NPI Log compression enabled | |
| | 0 | NPI RICE compression enabled | |
| 118 | 6-7<br>5<br>4 | PAD<br>NPD RICE compression enabled<br>NPD Log compression enabled | |
| | 0-3 | NPD Accumulation time | |
| | 0-3 | NPD1 mode | |
| 119 | 4-7 | NPD2 mode | 0: not in use<br>1: raw data<br><br>2: bin matrix (0 0 0)<br>3: bin matrix (0 0 1), (0 1 0) or (1 0 0)<br>4: bin matrix (0 0 2), (0 2 0) or (2 0 0)<br>5: bin matrix (0 1 1), (1 0 1) or (1 1 0) |
| | 0-3 | NPD1 mode | 6: bin matrix (0 1 2), (1 0 2), (0 2 1), (1 2 0), (2 0 1) or (2 1 0)<br>7: bin matrix (0 2 2), (2 0 2) or (2 2 0)<br>8: bin matrix (1 1 1)<br>9: bin matrix (1 1 2), (1 2 1) or (2 1 1)<br>10: bin matrix (1 2 2), (2 1 2) or ( 2 2 1)<br>11: bin matrix (2 2 2)<br><br>12: phd mode<br>13: tof mode<br><br>NOTE: Although reduction tables for bin matrixc can be defined independendently all default modes in macros are defined so that bin matrix is of type (0 0 0), (1 1 1) or (2 2 2) for both NPDs simultaneosly. |
| | | | |

There are a few spare bits. They are used to align 8bit signals to 8bit fields. Spare bits can be allocated later for some other use.

Software signal fields:

*ref: All values named *ref are monitored by software. They represent values written to some hardware register, typically values commanded by TC.

sw_version: sw_version is one 16-bit number defining the software version. The versionnumbering scheme is TBD. This value can be used to track definition of (possibly) changed HK packet structure. Sw_version will always be the first 16-bit field in every HK packet.

cpu_load: Load of cpu. The number will tell how much of the cpu'sr resources are in use (it will correspond to 'spare' time of cpu running in dummy loop).

sw_mode: sw_mode defines software mode (ie. experiment mode)

| Mode | Mode name |
|---|---|
| 1 | ASPSafe |
| 2 | ASPHK |
| 3 | ASPCal |
| 4 | ASPLow |
| 5 | ASPNorm |
| 6 | ASPHigh |
| 7 | ASPBurst |

els_mode:

| Mode | Mode name |
|---|---|
| 0 | ELSB0 |
| 1 | ELSH0 |
| 2 | ELSN0 |
| 3 | ELSL0 |
| 4 | ELSB1 |
| 5 | ELSH2 |
| 6 | ELSN3 |
| 7 | ELSL4 |
| 8 | ELSBx |
| 9 | ELSHx |
| 10 | ELSNx |
| 11 | ELSLx |

npi_mode: Npi mode is just a number used to define the Integration time. Integration time can be calculated in the following way:

*Int.Time = 2^(npi_mode) * 31.25ms*

*The* following values correspond to predefined modes:

| Mode | Mode name |
|---|---|
| 3 | NPIH |
| 4 | NPIN |
| 5 | NPL |

npdx_mode:

| Mode | Mode name |
|---|---|
| 0 | Disabled |
| 1 | NPDHR |
| 2 | NPDNR |
| 3 | NPDLR |
| 4 | NPDxR |
| 5 | NPDHB0 |
| 6 | NPDNB0 |
| 7 | NPDLB0 |
| 8 | NPDxn |

### 8.2.2Source data field for IMA

After headers, there will be the source data field. For the HK report packet, it will be as shown below:

| *Byte* | *Bits* | *Field* | *Note* |
|---|---|---|---|
| **Source data field** | | | |
| 16 | 8-15 | PAD | PAD=0 |
| | 0-7 | SID | SID=10 |
| 18-41 | | IMA Housekeeping packet data (24 bytes) | |

The content of the IMA Housekeeping packet data is defined by the IMA team and can be found in the ICA-IMA TC/TM Data Formats and Related Software Aspects Document issued by Hans Borg at IRF dated 2002-04-07 . The content of the source data field is exactly the same as the data fields of 4 link packets sent by IMA to the MU.

IMA new hk definition.

| Word offs. | Bits. | Content. | | Table pos. | Parameter. |
|---|---|---|---|---|---|
| 0 | 15-10 | Mode. See below. | | 0 | mode |
| | 9-8 | Cmd status | | 9 | hk_prm |
| | | 0=Ok | (Ok) | | |
| | | 1=Invalid | (Inv) | | |
| | | 2=Out of range | (Out) | | |
| | | 3=Erroneous | (Err) | | |
| | 7-0 | HV switches | | 10 | ad_prm |
| | 7 | Deflection HV logical | (ref) | | |
| | 6 | Deflection LV logical | (ref) | | |
| | 5 | Entrance HV logical | (ref) | | |
| | 4 | Grid LV logical | (ref) | | |
| | 3 | Pacc. HV logical | (ref) | | |
| | 2 | +28V main | | | |
| | 1 | +28V opto | | | |
| | 0 | +28V mcp | | | |
| 1 | 15 | Cmd. toggle Numeric 0/1 | | 12 | hk_prm |
| | 14-12 | Sid nr | | 1 | sid_nr |
| | 0 | Minimum | (Min) | | |
| | 1 | Normal | (Nrm) | | |
| | 2 | Burst | (Bst) | | |
| | 3 | Calibration | (Cal) | | |
| | 4 | Special | (Spc) | | |
| | 5 | Test | (Tst) | | |
| | 11-8 | +28V presence | | 11 | ad_prm |

| | | | | | |
|---|---|---|---|---|---|
| | 11 | HV enable/disable | | | |
| | 10 | Main | | | |
| | 9 | Opto | | | |
| | 8 | Mcp | | | |
| | 7-0 | Fifo filling (F8)<br>Numeric F8 code. See below. | | 2 | fifo_fill |
| 2 | 15-0 | Cmd return<br>Numeric (hex) | | direct from tc_decoder | |
| 3 | 15-8 | Opto HV monitor | | 13 | ad_prm |
| | 7-0 | Mcp HV monitor | | 14 | ad_prm |
| 4 | 15-8 | Deflection HV monitor15 | | ad_prm | |
| | 7-0 | Deflection LV monitor | | 16 | ad_prm |
| 5 | 15-8 | Pacc. HV monitor | | 17 | ad_prm |
| | 7-0 | Grid LV monitor | | 18 | ad_prm |
| 6 | 15-8 | Sensor temperature. | (Sns) | 19 | ad_prm |
| | 7-0 | Dpu temperatur. | (Dpu) | 20 | ad_prm |
| 7 | 15 | Direct command switch | | 3 | switches |
| | 14-12 | Pacc. low level | ref. | 4 | dta_12bit[3] |
| | 11-0 | Deflection HV reference | | 21 | dig_dflhv |
| 8 | 15 | Alt. Pacc. (Opera=Fix/Alt) | 5 | switches | |
| | 14-12 | Pacc. high level ref. | | 6 | dta_12bit[4] |
| | 11-0 | Deflection LV reference | | 22 | dig_dfllv |
| 9 | 15 | Pacc. level (High/Low) | | 23 | ms.flag |
| | 14-12 | Grid LV reference | | 24 | dta_12bit[2] |
| | 11-0 | Entrance HV reference | | 25 | dig_entr |
| 10 | 15 | Deflection HV (Opera=Stp/Fix) | | 26 | switches |
| | 14-12 | Opto default reference | | 7 | dta_12bit[0] |
| | 11-9 | Mcp default reference | | 8 | dta_12bit[1] |
| | 8-0 | Entrance upper HV monitor | 27 | ad_prm | |
| 11 | 15 | Entrance HV (Opera=Stp/Fix) | 28 | | switches |
| | 14-12 | Opto current reference | | 29 | Optocur |
| | 11-9 | Mcp current reference | | 30 | Mcpcur |
| | 8-0 | Entrance lower HV monitor | 31 | ad_prm | |

Modes.

==========

| Minimum | Mnemonic | |
|---|---|---|
| 0 | Idle | |
| 1 | Mmom | (Moments only) |
| 2 | Mspo | (Spectras only) |
| 3 | Mmsp | (Moments and Spectras) |
| 4 | Msis | (Selected Ion Species) |
| 5 | Mexm | (Energy Mass matrix) |
| 6 | Void | |
| 7 | Void | |

| Normal | Mnemonic | |
|---|---|---|
| 8 | Nrm0 | (Normal 0) |
| 9 | Nrm1 | |
| 10 | Nrm2 | |
| 11 | Nrm3 | |
| 12 | Nrm4 | |
| 13 | Nrm5 | |
| 14 | Nrm6 | |
| 15 | Nrm7 | |

| Burst | Mnemonic | |
|---|---|---|
| 16 | Har0 | (High angular resolution 0) |
| 17 | Har1 | |
| 18 | Har2 | |
| 19 | Har3 | |
| 20 | Har4 | |
| 21 | Har5 | |
| 22 | Har6 | |
| 23 | Har7 | |

| Burst | Mnemonic | |
|---|---|---|
| 24 | Exm0 | (Energy Mass matrix 0) |
| 25 | Exm1 | |
| 26 | Exm2 | |
| 27 | Exm3 | |
| 28 | Exm4 | |
| 29 | Exm5 | |
| 30 | Exm6 | |
| 31 | Exm7 | |

| Special | Mnemonic | |
|---|---|---|
| 32 | Test | |
| 33 | Cal1 | (Calibration 1) |

| | | |
|---|---|---|
| 34 | Cal2 | (Calibration 2) |
| 35 | Fake | (Faked science data) |
| 36 | Void | |
| 37 | Void | |
| 38 | Void | |
| 39 | Void | |

```
/*-------------------------------------------------------
Fifo filling must be unpacked by int unpack_f8(int acc)
-------------------------------------------------------*/

int Astat5a::unpack_f8(int acc)
{
int exp;

     exp=(acc >>4) &0xF;
     if(exp>1) {
          acc=(acc & 0xF) | 0x10;
          acc=acc<< (exp-1);
     }
     return acc;
}
```

# 9.SCIENCE DATA

## 9.1General

## 9.2Science data production modes

## 9.3Science data packet formats

### 9.3.1General

Definitions are subject to change.

All packages will have the normal TM header and Data field header in front of the package.

The Lossy compression scheme will be used only if the RICE (lossless) compressed package is larger than the packet size.

If the measurement mode is changed before the data for one packet is completely measured, the packet will be cut on the starting place of invalidity. Hence, the data sent to the ground is valid (in this sense) but the set is not necessarily complete. This can be identified by the packet length (in the uncompressed case it's smaller than normal) or as a smaller amount of decompressed data (in compressed case). Of course, this kind of recovery is not always possible.

### 9.3.2Science data packet types

The Science packets produced in the Main Unit have data types and subtypes. The data Type (4bits) defines mainly an instrument the packet is related to and the subtype (4bits) specifies the packet type within an instrument packet. Packet types and subtypes are allocated as follows.
The Main Unit will also format telemetry packets coming from IMA. These will be formatted to the ESA packet TM format and sent to the s/c. Science data coming from IMA is not analyzed by any means in the Main Unit.

| *Data Type* | *Data subtype* | *Data type name* | *Description* |
|---|---|---|---|
| 0 | 0 | Dummy | Doesn't contain anything meaningful |
| ***ELS Data Packages*** | | | |
| 1 | 0 | ELS Engineering information | First ELS packet within one scan cycle. Contains engineering information needed for analysis of ELS data. No science data included |
| | 1 | ELS Complete sweep | Data from one complete sweep included |
| | 2 | ELS Sweep step 0-63 | Data from first 64 steps in one sweep |
| | 3 | ELS Sweep step 64-127 | Data from latter 64 steps in one sweep |
| ***NPD1 data packages*** | | | |
| 2 | 0 | NPD raw data | NPD1 data produced in raw data mode |
| | 1 | NPD binning data | NPD1 data produced in bin matrix mode |

| *Data Type* | *Data subtype* | *Data type name* | *Description* |
|---|---|---|---|
| | 2 | NPD TOF mode | NPD1 data in Time-of-Flight mode |
| | 3 | NPD PHD mode | NPD1 data in Pulse height distribution mode |
| ***NPD2 data packages*** | | | |
| 3 | 0 | NPD raw data | NPD2 data produced in raw data mode |
| | 1 | NPD binning data | NPD2 data produced in bin matrix mode |
| | 2 | NPD TOF mode | NPD2 data in Time-of-Flight mode |
| | 3 | NPD PHD mode | NPD2 data in Pulse height distribution mode |
| ***NPI data packages*** | | | |
| 4 | 0 | NPI Normal mode data | NPI data in normal mode |
| | 1 | NPI Stepping mode | NPI data in deflection voltage stepping mode |
| ***Engineering data packages*** | | | |
| 5 | 0 | Solar sensor information | Status of Solar sensor 1&2 in each sample irq during one scan. |
| | 1 | Scanner information | Scanner position on each sample irq in one scan. |

### 9.3.3IMA telemetry packets

IMA telemetry packets will be sent almost as they are received in the Main Unit. The structure of the IMA telemetry packets are as follows: The time tag of the TM packet will be the time of receiving the first link packet from IMA (TBD). Time will be the same for all packets built from the same IMA packet.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 16 | | Error status | 0: No errors identified by MU<br>others: first invalid word in IMA data | |
| 17 | | IMA SID | | |
| 18-last | | IMA packet | | Maximum 2046 words of IMA telemetry packet |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

### 9.3.4ELS telemetry packets

An ELS data packet can contain a maximum of 128 steps*16 sectors = 2048 words of (16-bit) raw data. Based upon whether compression is enabled or not, the data may fit in a single packet or may have to be split into 2 packets, with each packet comprised of 64 steps.

The following table represents the ELS packet header that is common to all ELS packets.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 16-17 | | Science data Header | SW version | |
| | 8-15 | | spare | |
| | 4-7 | | Data type | 1 = ELS Packet |
| | 2-3 | | PAD | |

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| | 0 - 1 | | ELS packet subtype | 0 = ELS engineering information<br>1 = ELS data steps 0-127<br>2 = ELS data steps 0-63<br>3 = ELS data steps 64-127 |
| 20-25 | | | SCET Time | (on start of first sweep (ie. 'engineering' sweep) in this scan) |
| 26-27 | | | ELS sector mask | |
| 28 | 7 | ELS compression scheme | Spare | |
| | 6 | | Rice compression | |
| | 5 | | Log compression (16 to 8 bit) | Note: If RICE compression is used, values will be 16bits in width, but the range for the value is 0-255. This is to optimize both performance and compression. |
| | 3-4 | | Energy compression | 0= 1 step, 1=2 steps,<br>2=4 steps , 3= undefined |
| | 0-2 | | Time compression | 0= 1 sweep, 1=2 sweeps,<br>2=4 sweeps, 3=8 sweeps,<br>4=16 sweeps<br>5-7=undefined |
| 29 | | | spare | |

### 9.3.4.1ELS engineering information

In the beginning of every scan cycle, some engineering information is sent in a separate ELS science packet. This information is needed for the analysis of the ELS science data that is returned during that scan cycle. This packet is built in the following way, starting from byte 30.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 30 | 3-7 | | spare | |
| | 2 | | Scanner direction | 0 = 0 - 180<br>1 = 180 - 0 |
| | 0-1 | | Scanner speed | 0 = staying<br>1 = 32s scan<br>2 = 64s scan<br>3 = 128s scan |
| 31 | | | Scanner position | On start of scan (or step) period |
| 32 | | ELS Status | TBD and TBV | |
| 33 | | | ELS temperature | |
| | | | | |
| 34 | | | ELS MCP reference | |
| 35 | | | ELS MCP monitor | |
| 36 | | | ELS Screen grid reference | |
| 37 | | | ELS Screen grid monitor | |
| 38-39 | | | ELS Deflection reference step1 | |
| 40-41 | | | ELS Deflection monitor step 1 | |
| 42-43 | | | ELS Deflection ref. step 2 | |
| 44-45 | | | ELS Deflection mon. step 2 | |
| Etc... | | | | |
| 546- | | | ELS Deflection ref. step 128 | |

| Byte | Bits | Field | Subfield | Remark |
|---|---|---|---|---|
| 547 | | | | |
| 548-549 | | | ELS Deflection mon. step 128 | |

### 9.3.4.2ELS data

After the first packet of ELS engineering data is sent, the remaining ELS packets will contain ELS science data. There is three types of packets: (1) one containing data from one complete sweep (128 steps), (2) one containing the first 64 steps from one sweep, and (3) one containing the latter 64 steps from one sweep. All ELS packets will be sent in a row so it's possible to find the order of these packet from the Packet sequence count field.

In this case, the packet will be as follows:

| Byte | Bits | Field | Subfield | Remark |
|---|---|---|---|---|
| 30 | 3-7 | | spare | |
| | 2 | | Scanner direction | 0 = 0 - 180<br>1 = 180 - 0 |
| | 0-1 | | Scanner speed | 0 = staying<br>1 = 32s scan<br>2 = 64s scan<br>3 = 128s scan |
| 31 | | | Scanner position | On start of scan (or step) period |
| | | | | |
| 32 | | Data | Sector 0, step 1, sweep 1 | Data from one sweep. If no log, energy nor sectormask type of comresssion is applieed to the data it will be divided to two parts. (ELS data packet subtypes 2 and 3) . In this case both packets will have same time tag on packet bytes 6-11. However, sequence count will differ between these two packets. |
| | | | Sector 1, step 1, sweep 1 | |
| | | | .... | |
| | | | Sector 0, step 2, sweep 1 | |
| | | | Sector 1, step 2, sweep 1 | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

### 9.3.5NPD telemetry packets

| Byte | Bits | Field | Subfield | Remark |
|---|---|---|---|---|
| 16-17 | | Science data Header | SW version | |
| 18 | | | spare | |
| 19 | 4-7 | | Data type | 2: (NPD1 packet)<br>3: (NPD2 packet) |
| | 0-3 | | NPD packet subtype | 0 = NPD raw data<br>1 = NPD binning data<br>2 = NPD TOF mode<br>3 = NPD PHD mode |

### 9.3.5.1NPD Raw data packet

Because raw data events are 25bits in width and the compression scheme used is 16bit RICE, one has to do a trick in order to make the compression as effective as possible. These 25bit events are divided in the packet into two separate 'data streams', both containing 512 words. Stream_1 words will have following structure :

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 0-1 | 5-15 | Stream_1 word | TOF | |
| | 3-4 | | Direction | |
| | 0-2 | | Coincidence | |

Stream_2 words will have the following structure :

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 0-1 | 8-15 | Stream_2 word | PAD | |
| | 0-7 | | Stop PH | |

The overall structure for the NPD raw data packet will be as follows:

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26-27 | 8-15 | Scanner information block | Scanner position | In the beginning of sample |
| | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPD bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |
| | 1 | | Log compression enabled | Always 0 for raw data mode (0 = disabled) |
| | 0 | | RICE Compression enabled | |
| 29-30 | 8-15 | NPD registers | FRONTCTRL | |
| | 0-7 | | MAINCTRL | |
| | | | STAT | |
| | | | TDCRD | |
| | | | CALIB11 | |
| | | | CALIB12 | |
| 31 | | | CALIB21 | |
| 32 | | | CALIB22 | |
| 33 | | | STARTCNT | |
| 34 | | | STOP0CNT | |
| 35 | | | STOP1CNT | |
| 36 | | | STOP2CNT | |
| 37 | | | TOFCNT | |
| 38 | | | RAWCNT | |
| 39 | | | | |
| 40 | | | | |
| 41 | | | | |
| 42 | | | | |
| | | | | |
| 43 | | Data | Stream 1:<br>512 * Stream_1 words<br>Stream 2:<br>512 * Stream_2 words | If applied, RICE compression is used in 'one-shot' over both streams. |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| | | | | |
| | | | | |

### 9.3.5.2NPD Bin matrix data packet

The NPD Bin matrix data packet will contain data from 768 bin counters. The data will be ordered so that bin number 0 is the first one found in the packet.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26 | | Scanner block information | Scanner position | In the beginning of this sample. |
| 27 | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPD Bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |
| | 1 | | Log compression enabled | 0 = disable<br>1 = enable |
| | 0 | | RICE Compression enabled | |
| 29 | | | PAD | |
| 30-31 | 12-15 | Treshold values | PAD | |
| | 8-11 | | Treshold 3 | 0: Matrix 0, 16x16<br>1-14: Matrix 1, 2x16<br>15: Matrix 2, 1x16 |
| | 4-7 | | Treshold 2 | |
| | 0-3 | | Treshold 1 | |
| 32 | | NPD Registers | CALIB11 | |
| 33 | | | CALIB12 | |
| 34 | | | CALIB21 | |
| 35 | | | CALIB22 | |
| 36 | | | STARTCNT | |
| 37 | | | STOP0CNT | |
| 38 | | | STOP1CNT | |
| 39 | | | STOP2CNT | |
| | | | | |
| 40 | | Data | Bin number 0x000 | Might be RICE compressed<br>Number of bins returned is dependent upon the threshold mode, so the maximum number of bins returned would be 16x16x3 = 300 bins (0x000 to 0x2ff)<br>The 3 represnts the number of directions. |
| | | | Bin number 0x001 | |
| | | | Etc ... | |
| | | | Bin number 0x2ff | |
| | | | | |
| | | | | |

### 9.3.5.3NPD TOF mode data packet

When NPD is run in the special TOF mode, the data will be packeted into TOF mode packets which contain 3 different 'TOF' tables.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26-27 | 8-15 | Scanner information block | Scanner position | In the beginning of sample |
| | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPD bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| | 1 | | Log compression enabled | 0 = disable<br>1 = enable |
| | 0 | | RICE Compression enabled | |
| 29 | | | PAD | |
| 30 | | NPD Registers | CALIB11 | |
| 31 | | | CALIB12 | |
| 32 | | | CALIB21 | |
| 33 | | | CALIB22 | |
| 34 | | | STARTCNT | |
| 35 | | | STOP0CNT | |
| 36 | | | STOP1CNT | |
| 37 | | | STOP2CNT | |
| | | | | |
| 38- | | Data | First data word in TOF mode | 768 data words (or bytes), Might be RICE compressed |
| | | | | |
| | | | | |
| | | | | |

### 9.3.5.4NPD PHD mode data packet

When NPD is run in the special PHD mode, the data will be packeted into PHD mode packets which contain the least significant bytes of the stoparray.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26-27 | 8-15 | Scanner information block | Scanner position | In the beginning of sample |
| | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPD bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |
| | 1 | | Log compression enabled | Always 0 for PHD mode<br>(0 = disabled) |
| | 0 | | RICE Compression enabled | |
| 29 | | | PAD | |
| 30 | | NPD Registers | CALIB11 | |
| 31 | | | CALIB12 | |
| 32 | | | CALIB21 | |
| 33 | | | CALIB22 | |
| 34 | | | STARTCNT | |
| 35 | | | STOP0CNT | |
| 36 | | | STOP1CNT | |
| 37 | | | STOP2CNT | |
| | | | | |
| 38-85 | | Data | Least significant byte of STOPARRAY channel 0 | 48 data bytes (or bytes), Might be RICE compressed |
| | | | Least significant byte of STOPARRAY channel 1 | |
| | | | ... | |
| | | | Least significant byte of STOPARRAY channel 47 | |

### 9.3.6NPI telemetry packets

One NPI telemetry packet will consist of 32 samples. This leads to 32 samples*32sectors = 1024 words of raw 16-bit data. This data can be compressed. Whether the packet is compressed or uncompressed can be determined using the NPI compression flags that are returned in the MU full housekeeping packet and in Byte 28 of the NPI science packet.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 16-17 | | Science data Header | SW version | |
| 18 | | | PAD | |
| 19 | 4-7 | | Data type | 4 = NPI packet |
| | 0-3 | | NPI packet subtype | 0 = NPI data (normal mode)<br>1 = NPI data (defl stepping mode) |

### 9.3.6.1NPI normal mode data packet

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26-27 | 8-15 | Scanner information block | Scanner position | In the beginning of sample |
| | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPI bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |
| | 1 | | Log compression enabled | Converts 16bit counts to 8 bit bit values |

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| | 0 | | RICE Compression enabled | |
| 29 | | | PAD | |
| 30-33 | | | NPI Sector mask | |
| 34- | | Data | Sample 0, sector 0 | Might be RICE compressed |
| | | | Sample 0, sector 1 | |
| | | | ... | |
| | | | Sample 31, Sector 31 | |
| | | | | |

### 9.3.6.2NPI Deflection stepping mode data packet

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26-27 | 8-15 | Scanner information block | Scanner position | In the beginning of sample |
| | 3-7 | | PAD | |
| | 2 | | Scanner direction | |
| | 0-1 | | Scanner speed | |
| 28 | 4-7 | NPI bit information | Accumulation time | Time = $2^N$ * 31.25ms |
| | 2-3 | | PAD | |
| | 1 | | Log compression enabled | |
| | 0 | | RICE Compression enabled | |
| 29 | | | PAD | |
| 30-33 | | | NPI Sector mask | |
| 34-37 | | | NPI deflection status mask | |
| 38- | | Data | Sample 0, sector 0 | Might be RICE compressed |
| | | | Sample 0, sector 1 | |
| | | | ... | |
| | | | Sample 31, Sector 31 | |
| | | | | |

### 9.3.7Engineering telemetry packets

There are two packets of so called 'engineering type' packets: the solar sensor information packet and the scanner information packet. Solar sensor information is a readout of the solar sensors in each sample interrupt during one scan cycle. The Scanner position packet reports on the scanner position on each sample irq during one scan cycle.

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 16-17 | | Science data Header | SW version | |
| 18 | | | PAD | |
| 19 | 4-7 | | Data type | 5 = Engineering packet |
| | 0-3 | | Engineering packet subtype | 0 = Solar sensor information<br>1 = Scanner information |

### 9.3.7.1Solar sensor information packet

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26 | | | Scanner position | At start |
| 27 | 7 | | PAD | |
| | 6 | | Scanner direction | |
| | 4-5 | | Scanner speed | |
| | 1-3 | | PAD | |
| | 0 | | RICE compression enabled | |
| 28- | 7 | | Solar sensor 1 status pos 0 | |
| | 6 | | Solar sensor 2 status pos 0 | |
| | … | | | |
| | 1 | | Solar sensor 1 status pos 3 | |
| | 0 | | Solar sensor 2 status pos 3 | |
| … | | | | |
| Last | 7 | | Solar sensor 1 status pos last-3 | |
| | 6 | | Solar sensor 2 status pos last-3 | |
| | … | | | |
| | 1 | | Solar sensor 1 status pos last | |
| | 0 | | Solar sensor 2 status pos last | |
| | | | | |

### 9.3.7.2Scanner information packet

| *Byte* | *Bits* | *Field* | *Subfield* | *Remark* |
|---|---|---|---|---|
| 20-25 | | | Sample start time (SCET) | |
| 26 | | | Scanner position | At start |
| 27 | 7 | | PAD | |
| | 6 | | Scanner direction | |
| | 4-5 | | Scanner speed | |
| | 1-3 | | PAD | |
| | 0 | | RICE compression enabled | |
| | | | | |
| 28- | | Data | Scanner position 0 | Up to 2048 positions (each is 1 byte), which corresponds to 64sec. Can be RICE compressed. |
| | | | Scanner position 1 | |
| | | | ... | |
| | | | Scanner position last | |
| | | | | |